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DEPENDENCY OF AIR PERMEABILITY ON FABRIC POROSITY

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ABSTRACT: Textile fabric is considered to be porous material. Great amount of circulating air through the textile fabric is influenced by size of air pores. Pore optimal size that depends on structure and material composition, has other important qualities of fabric. Static enclosed air in the fabric pores is its heat insulator. Porosity influences the fabric usage. Special kinds of fabric should have as small porosity as possible. With regard to usual kinds of fabric there is sought after such a porosity value that positively influences other fabric qualities.

KEY WORDS: air permeability, porosity, variation coefficient of air permeability, thread count, basic weight, weight of length, weave, threshold value, fabric filling, surface porosity and volume porosity.

1. INTRODUCTION

The aim of this lecture is to find mutual dependency of fabric porosity on air permeability. At the same time we evaluate contemporary methods of measurement of these qualities. The basic measurements of compared fabrics were made at the faculty of textile TU Liberec. Consequently follows the measurements of the same parameters on 10 samples of textile fabric at our department of industrial design in Ružomberok. The measurements were made on the samples with similar basic parameters. We were verifying this way the usage possibility of picture analysis Lucy for porosity measurement. This way of measurement is not being used so far in the accredited laboratories in Slovak Republic. We think that other verification of this method on larger range of textile fabric proves that the usage probability in praxis is possible.

1.1 Dress function.

Comfort can be characterised as the feeling when we feel well in dress. The main function of the dress is protection from atmospheric exposure. The dress should protect us from coldness and warmth – we talk about thermal comfort of the dress. The dress should permit the body to breathe freely. On the body can not be liquid sweat. We are talking about transmission of air, water vapour and moisture. We should feel well in dress and from aesthetic point of view the dress should represent us but it should not differentiate us too much from other people. Generally we can say that dress beside the aesthetic and utility function fulfils also the function: symbolic, ritual, representative. Dress function is formed by its qualities. Textile fabric qualities are divided into: utility, manufacturing, physical, chemical. The large group of utility qualities contains also physiological qualities as: air permeability, water vapour permeability, water permeability, warmth permeability, aesthetic qualities, durability and other qualities. Generally the textile fabric is divided into:

- textile fabric for the direct contact with skin
- textile fabric for indirect contact with skin
- textile fabric for household and domestic textile fabric
- technical textile fabric

.The greatest relevance of physiological qualities is seen mainly in the field of textile fabrics that are in the direct contact with skin. Knowledge of textile fabric structure from mathematic-physical point of view is source indication for evaluation of physiological qualities of textile fabric.

2. THEORETICAL ASSESSMENT OF POROSITY

2.1 Air permeability through textile fabric.

Air permeability is dependent on a range of factors that influence the usage of textile fabric. Special textile fabric as e.g. granary-fabric, filtration fabric and textile fabric for parachute should have air permeability as low as possible. Clothing fabrics with the low air permeability can be the source of small comfort. The air traverses through the textile fabric to the lower level in the case that surface textile fabric is in physical environment that has on both sides different barometric pressure and is porous. For measuring of air permetability was designed the whole range of methods. Nowadays measures the air permetability the device FX 3 300 (textest A6). Device measures the speed of air flow, that passes vertically through the test sample under certain conditions (test surface, decrease of pressure and time). It is fitted with forced draft blower, that presses air through test sample the way that the other side of tested fabric surface rises recommended pressure decrease. After the stabilised conditions are achieved the air flow is recorded q_v ($l\ s^{-1}$). The test is repeated on different places of textile fabric minimally 10 times. The result of the test is:

- average air permeability R ($cm.s^{-1}$)
- variation coefficient (%)

Test condition:	- test surface 20 cm^2
	- pressure decrease : 200 Pa (recommended for clothing fabrics)
Measured values q_v	- 386,15 $l.\ s^{-1}$

Calculation of air permeability R ($cm.s^{-1}$)

$$R = \frac{q_v}{A}.0{,}167, \tag{1}$$

where

q_v - arithmetic average of air flow speed ($l.s^{-1}$), A is tested surface of textile fabric (20 cm^2), 0,167 is counting constant from cubic decimetre per second to square centimetre, to centimetres per second.

2.2 Expression of surface porosity with the use of simple ideal projective textile fabric.

Yarn surface is calculated as following:

$$A = d_o/D_o + d_u/D_u - d_o d_u. \tag{2}$$

The whole surface of rectangle is $A = D_o.D_u$ from this surface filling CF is equal to ratio of these surfaces $CF = D_o.d_o + Du.du - do.du.Do.Du$

Surface porosity $Po = 1 - CF$

This porosity is equal to porosity that was used at calculating of air permeability.

Calculated values :	CF – 0.7662 for cotton textile fabric
	CF – 0.83 for propylene textile fabric
	Po – 0.2338 for cotton textile fabric
	Po – 0.17 for propylene textile fabric

3. EXPERIMENTAL PART

3.1 Evaluation of air permeability and porosity.

The aim of our evaluation is dependence of air permetability on porosity of two kinds of textile fabric. Cotton fabric and polypropylene fabric used for measurement are with their basic parameters similar see Tab. 1., Fig. 1,2. It was proved, that for denser textile fabric exists a good correlation between the air porosity and permeability for open thinner structures is the correlation between air permeability and porosity weaker. As long as these two examined textile fabric have thinner structure we verified with measurements this weaker dependence and also we compared the difference between textile fabric of different chemical substance. The measurements were made on textile faculty TU Liberec. For verification of this dependence we choose other 10 samples of cotton fabrics on which we measured air porosity and permeability directly in our department. For analysis of results are used average values and variation coefficients defined from decomposition of dispersions. There are listed basic possibilities of porosity expression of textile fabric constructional parameters. For porosity expression is used the light transmission through picture analysis LUCIA and these values are compared with results of air permeability measured on device FX 3 300.

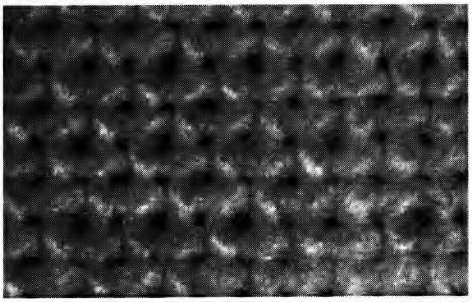

Fig. 1: Cotton fabric structure

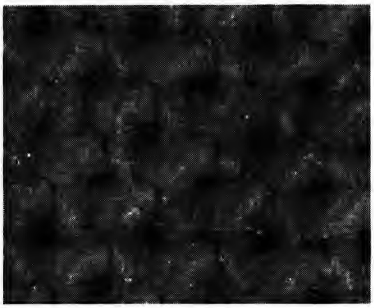

Fig. 2: POP fabric sturcture

The measurements were made at our department on the device FF 12 (older type of device FX).

Test condition:
- test surface 20 cm^2
- pressure decrease 100 Pa (because of high porosity the value was regulated to 100 Pa). Values of air permeability R ($cm.s^{-1}$) are shown in Tab.1

Tab.1:

sample no. 1	sample no. 2	sample no. 3	sample no. 4	sample no. 5	sample no. 6	sample no. 7	sample no. 8	sample no. 9	sample no. 10
Air permeability counting R ($cm.s^{-1}$)									
2176	3635	3715	3980	3995	4085	2910	29820	3120	3090
Air permeability counting R ($cm.s^{-1}$)									
151	253	259	277	278	284	203	196	217	215

3.2 Porosity display

Microscopical appereances show the textile fabric with pores and surface of set -screened pores. For achieving of distinguishing ability between binding points of textile fabric and vents in it. see Fig.3,4 – binaric image is shown, not coloured. Importance of setting – image contrasting and its following measurement of surface of pores is highlighted by comparing of Fig.3 and Fig.4.

Fig. 3: Previous non – contrasting image

Fig. 4: Image after contrasting

Porosity measurements were made also on 10 samples on our workstation with the use of image analyses Lucia G. with the treshold value 58.The results of measurements are shown in the Tab.2.

Tab.2:

No. of sample	Middle value of porosity (%)	Selective authoritative porosity divergence	Covering middle Value (%)
1	4,38	2,5	95,62
2	6,51	2,82	93,49
3	5,02	2,43	94,98
4	6	2,22	94
5	5,97	1,62	94,03
6	7,89	2,6	92,11
7	3,97	3,2	96,03
8	3,05	1,72	96,95
9	4,54	1,96	95,46
10	2,5	0,88	97,5

4. CONCLUSION

Porosity measurements with image analyses Lucy show, that surface distribution of pores for weaving is irregular – Fig. 5. On the base of this assesment it is possible to estimate material irregularity of yarn of which the textile fabric is made. Air permeability measurements on devices FX are not always consistent with porosity measurements on image analyses Lucia. It is confirmed that for more open structures – thinner textile fabrics the correlation between constructional parameters and air permeability is weak. The method of porosity measurement and covering on image analyses Lucy is the base of complete analyse of textile fabric. The measurement results and mainly images of pores show the yarn characteristics of which the textile fabric is made. At the same time they influence utility and manufacturing characteristics of future textile fabric.

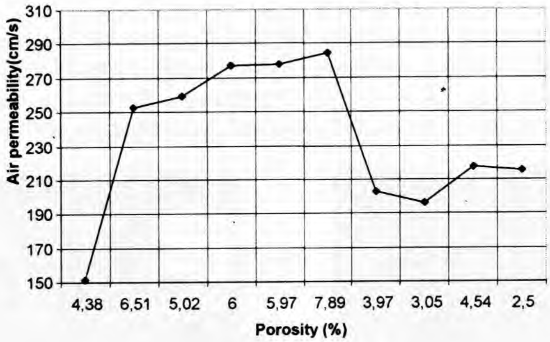

Fig. 5: Dependency of air permeability on porosity

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